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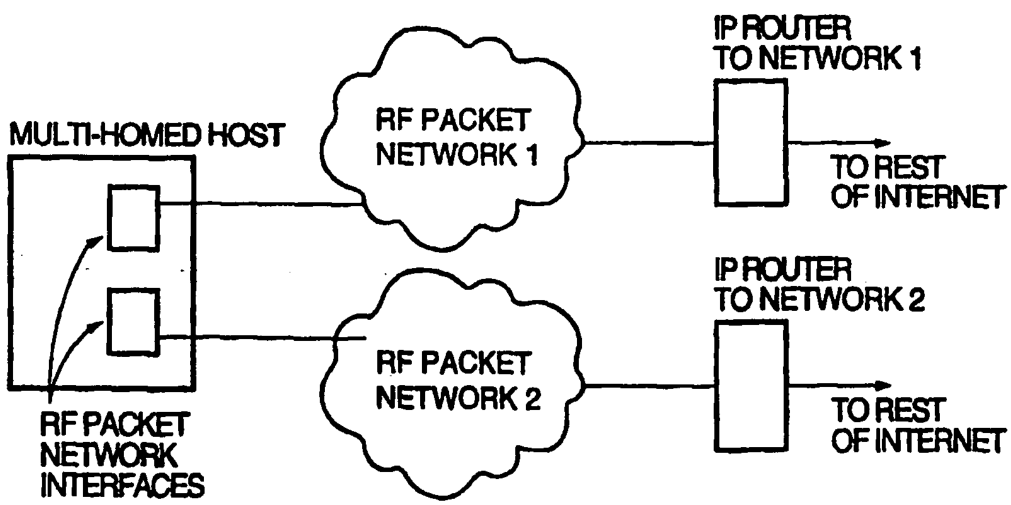

(57) Abstract

The present invention provides a system for combining separate and incompatible RF packet networks into a hybrid RF packet network offering the least expensive service possible simultaneously with unrestricted territorial coverage. The system comprises two (2) principal components: (i) Hybrid Network Radio (20) enabling access to the hybrid network (105) for a mobile subscriber (10); and (ii) Hybrid Network Gateway (80) enabling access to the hybrid network for a fixed subscriber (100). Both of these components incorporate modules enabling them to: (a) interface to the hybrid network as a single abstract data link with a single Internet address; (b) support access to and from the Internet for the subscribers attached to them; and (c) intelligently select the optimal RF path on which to forward packets through the hybrid network, based on dynamically changing impedance conditions in the individual RF packet networks.

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TELECOMMUNICATION SYSTEMS

FIELD OF THE INVENTION

The present invention relates to the field of wireless data communications using satellites and land-mobile radio in the form of terrestrial RF packet networks. More specifically, the invention relates to a system and method of combining satellite and terrestrial RF packet networks into a hybrid network and is embodied in fixed and mobile equipment capable of using this hybrid network.

DESCRIPTION OF THE PRIOR ART

Since the mid-1980's, a variety of mobile data communications networks, or *RF packet networks*, have been deployed in industrialized countries to provide services for packet data transmission and reception via wireless links to mobile vehicles. All of these networks have some form of *gateway* through which a computer in a fixed-location can transmit or receive data packets.

The connection between the gateway and a computer in a fixed-location is typically established using some data link technology such as X.25, Frame Relay, Ethernet and so forth, provided by a public telecommunications carrier, and with which the gateway equipment is compatible. Because the end-users of RF packet networks are typically charged on a per-packet basis by the operator of the gateway and the wireless data links, it is convenient to refer to the end-users as *subscribers*, which connect to the RF packet networks through *access devices*. Typically, a fixed subscriber connects to an RF packet network through a plug-in card adapter for the

data link to the gateway network whereas a mobile subscriber connects to an RF packet network through a radio modem which implements the airlink protocol of the specific RF network technology. Both the adapters and the radio modems are called network "access devices".

A *fixed subscriber* consists of a fixed-location computer with an access device in the form of an adapter for the data link to the gateway. A *mobile subscriber* consists of a mobile computer and an access device in the form of a radio-modem.

A common and persistent problem with RF packet networks is the limitation of the territorial coverage which they provide.

A number of mobile data communications networks based on satellites are becoming available which do not have these coverage limitations, but which are more costly to deploy. This is reflected in the rates that need to be charged to subscribers. Satellite-based networks are those which use satellites to provide the RF data link, called an *airlink*, to the mobile subscriber. This is in contrast to terrestrial networks which use fixed-location RF transceiver base stations to establish the airlink, deployed similarly to those in cellular telephony.

In order to provide the least expensive service possible simultaneously with unrestricted coverage, there is a recognition emerging in the mobile data communications industry, of the need to combine terrestrial RF packet networks with satellite networks. For a mobile subscriber, this would take the form of a single access

device incorporating radio modems for each network in the combination. The term currently being used to refer to such a device is *hybrid radio*.

It is important to note the architectural distinction between this combination of networks and the classical interconnection of two networks using incompatible data link technologies. In the classical interconnection scenario, computing devices connected to two heterogeneous networks may communicate with each other through the mediation of a *router* which is connected to both. The best-known and most ubiquitous example of interconnect technology is the Internet. The specifications for the Internet may be found in Postel, J., "Internet Protocol", RFC 791, USC/Information Sciences Institute, September 1981, the contents of which are incorporated herein by reference.

In designing a solution for the problem of combining complementary RF packet networks, the opportunity presents itself to enable the resulting combination to interconnect with the Internet. Consequently, the concept of a *router* plays a role in the principal components of the present invention. However, to the extent that the Internet solves a problem which is different from the one addressed by the present invention, it does not represent significant prior art.

Nevertheless, it is possible to design a solution based on a conventional Internet architecture. In such a solution, both mobile and fixed subscribers would have Internet addresses, called *IP addresses*, for each RF packet network to which they are attached. Each subscriber would become what is known, in the terminology of the Internet, as a *multi-homed host*.

Any Internet node wishing to communicate with a destination which is a multi-homed host, in such a manner as always to use an available, yet least expensive, route, needs to be aware of all the alternative IP addresses by which the destination can reached. It should also have knowledge of transient conditions along the alternative RF paths because these affect the choice of IP address to use in transmitting data to the destination. However, since the Internet mechanisms for propagating information about transient conditions are available only to Internet routers and not to Internet nodes in general, any Internet node sending data to a hybrid network subscriber cannot make an intelligent choice for the IP address to use. For these reasons, the multi-homed host solution would be inferior to the one provided by the present invention

SUMMARY OF THE INVENTION

The present invention provides a hybrid RF packet network which enables the subscriber to obtain coverage which is unrestricted in terms of geographic boundaries but which makes use of the satellite data links only when it is required. It also enables the subscriber to send or receive Internet datagrams. The system comprises two principal components:

1. A Hybrid Network Radio which constitutes a network access device for mobile subscribers.

2. A Hybrid Network Gateway, which constitutes a network access device for fixed-location subscribers.

From the subscriber's perspective, this system treats the combined radio network as a single abstract data link. Both the Hybrid Network Radio and the Hybrid

Network Gateway are addressable as Internet nodes which are *neighbours* attached to this link.

By definition, both the Hybrid Network Radio and the Hybrid Network Gateway have attachments, called *interfaces*, to two(2) or more RF packet network technologies. The actual mechanism for transmission across the abstract link between any Hybrid Network Radio/ Hybrid Network Gateway pair is a function of the relative costs of traversing the airlinks. For each airlink, this cost is called impedance, the value of which varies with transient conditions such as commercial terms for (a) transmission rates at different times of the day/week/month, and for (b) the length (in octets) of the data packet being transmitted, as well as the ability of a Hybrid Network Radio to transmit or receive over the airlink. Although the formula for impedance measurement may be different for any Hybrid Network or Hybrid Network Gateway, its application in terms of the variables used is the same for all datagrams transiting these nodes, regardless of their destination. Both the Hybrid Network Radio and the Hybrid Network Gateway always route traffic through the airlink with the lowest impedance and able to detect changes in the impedance value of each RF packet network.

BRIEF DESCRIPTION OF THE DRAWINGS

Figures 1(a) illustrates the classical interconnect scenario which is characteristic of the Internet and Figure 1(b) shows a method, inferior to the present invention, for using the Internet-based concept of a "multi-homed host" to create a hybrid network.

Figure 2 is a general schematic representation of the Hybrid Network Radio and Hybrid Network Gateway in relation to the combined RF packet networks.

Figure 3 is a detailed schematic representation of the Hybrid Network Radio.

Figure 4 is a detailed schematic representation of the Hybrid Network Gateway in relation to the proprietary gateways for each of the wireless networks and to the rest of the Internet

Figure 5 is a schematic representation of the routing mechanism which constitutes the essential innovative characteristic of the present invention.

Figure 6 is a schematic representation of the behavior of either the Hybrid Network Radio or the Hybrid Network Gateway when a report is received from an RF packet network that a previously transmitted packet has failed to reach its destination, or that a prior attempt to transmit a packet has failed.

Figure 7 Airlink Status Reporting is a schematic representation of the behavior of the Hybrid Network Radio when a report is received from the radio modem that RF contact with the packet network infrastructure has either been lost or re-established.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

Global System

Figure 1(a) is a schematic representation of the classical interconnect concept as it is applied in the architecture of the internet. This is shown in contradistinction to the nature of, and the solution for, the problem of hybrid networking. The internet solves the problem of data packets traversing two or more heterogeneous data links between source and destination computing devices, whereas hybrid networking deals with the choice of only one of several alternative RF paths to traverse along a route between the source and destination.

Figure 1(b) illustrates the "multi-homed host" approach to solving the latter problem as an example of a solution which would be inferior to the present invention for the reasons outlined in Prior Art.

Figure 2 shows the two (2) principal components of the present invention in relation to the RF packet networks that they combine. Hybrid Network Radio 20 is attached to a terrestrial RF packet network 60 and to a satellite network 65. Each of the RF packet networks have proprietary gateways to which Hybrid Network Gateway 80 is connected.

RF packet network 60 and its proprietary gateway 70 comprise a telecommunications service as does RF packet network 65 with proprietary gateway 75. There is not necessarily any relationship, either technical or commercial, between

both services. In other words, both services may be provided by two different telecommunications carriers who can remain unaware that Hybrid Network Gateways and Hybrid Network Radios are effectively creating a combined network.

The combined network 105 is treated as a single abstract data link technology. Any subscriber connected to this data link can have a unique Internet address. More specifically, each of the *interfaces* to this data link from both Hybrid Network Radio 20 and Hybrid Network Gateway 80 has only one Internet address.

Hybrid Network Radio

A Hybrid Network Radio in accordance with the present invention is shown in Figure 3. The hardware embodiment 20 of the Hybrid Network Radio contains re-usable software module 30 at the core of which is Internet Protocol module 35, called an *IP module*. IP modules are present in all computing devices which have an address on the Internet.

By definition, IP modules having only one interface to a specific data link technology are called *hosts*. An IP module with two(2) or more such interfaces, and with the ability to route traffic, received from one interface, to be transmitted on the other interface, is called a *router*.

The Hybrid Network Radio complies with the aforementioned definition of a router. To support IP communications with the mobile subscriber 10, it has PPP (Point-to-Point Protocol) interface 15. The specifications for the PPP may be found in

Simpson, W., Editor, "The Point-to-Point Protocol (PPP)", STD 50, RFC 1661, Daydreamer, July 1994, the contents of which are incorporated herein by reference.

For wide-area mobile communications, the Hybrid Network Radio has an array of interfaces to RF packet networks (data link technologies). Conceptually, these interfaces are for:

(1) A terrestrial RF packet network, labeled 45(a).

(2) A satellite RF packet network, labeled 45(b).

(3) Any additional RF packet networks which may offer a lower cost of communications under specific circumstances then either of the others. These are represented in Figure 1 as the arbitrary n'th RF packet network, labeled 45(c)

In a conventional Internet architecture, all these interfaces would have Internet addresses, called *IP addresses*. However, in terms of the conventional routing task of the IP module, these are all combined into a single abstract data link.

Hybrid Network Gateway

A Hybrid Network Gateway in accordance with the present invention is shown in Figure 4, relative to the proprietary gateways for each of the wireless networks and to the rest of the Internet. The Re-usable Software Module 30 of the Hybrid Network Radio is, as the name implies, re-used in Hybrid Network Gateway 80 and therefore all of its components, including the RF path switch, are identical in functionality.

Similarly to the Hybrid Network Radio's relationship with the mobile subscriber, the Hybrid Network Gateway interfaces to a fixed subscriber 100 through a generic IP interface 90. In other words, 90 is any interface to a network which can be assigned an Internet address and therefore enables the Hybrid Network Gateway to route between the Hybrid Network and the Internet. In this context, the fixed subscriber 100 is an Internet node.

Routing Mechanism

From the perspective of mobile subscriber 10 in Figure 3, the IP module in the Hybrid Network Radio has the same behavior as an IP module in any conventional router. It routes traffic between the PPP interface and the abstract data link which combines the RF packet networks However once traffic has been routed to the abstract data link, a choice must be made between an array of alternative RF paths. Module 40, which is not part of a conventional IP module, determines this choice, and is called an *RF path switch.*

The functionality of the RF path switch should be explained in contrast to the conventional Internet routing mechanism, which is as follows. The basic data unit in the Internet is called a *datagram*. As datagrams transit Internet routers, the routing decision taken by the IP module is a function of the destination address encapsulated in the header of the datagram. A router will mask out the host portion of the destination address in order to extract only the network portion. If the router incorporates an interface to that network, then the datagram can be delivered directly to its destination. Otherwise, it examines its routing table to find a route associated

with the target address and, if there is a route, it delivers the datagram to the network interface associated with that route. In other words, it passes the datagram along to the next hop indicated by the route.

In contrast to this, the datagram's destination address is not sufficient for the Hybrid Network Radio to determine the RF packet network interface to which the datagram should be delivered. Figure 5 shows that this is purely a function of the relative costs of sending the datagram, (encapsulated in a data link layer frame) along any one of the wireless data link paths. RF path switch 40 chooses the path of least impedance. Therefore if the impedance I_1 of RF packet network 60 is less than impedance I_2 along RF packet network 65, RF path switch 40 chooses 60 as the medium through which to transfer the datagram.

In a conventional IP router, the entries in its routing table can be dynamically changed as topological conditions in the Internet change. As routers are added or removed, or traffic congestion problems are reported, the routers which detect these phenomena can propagate the information throughout the Internet via a set of protocols in which only routers participate. As new information is received, the router may change some of its route entries.

In contrast, changes to the entries in the routing table of the IP module 35 are brought about by changes to the impedance values for the RF paths by which the entries in the routing table can be reached. These changes are the result of error reporting and the airlink status reporting mechanisms of the RF packet networks, which are described in the following two(2) sections. Furthermore, the IP module 35

and its RF path switch 40 do not propagate changes to routing table entries because the combined RF packet networks constitute, from an external perspective, a single abstract data link. Any transient conditions within this data link, such as the relative cost of traversing any of the RF media, are not significant to the "outside world".

Error Reporting

Most RF packet technologies include a mechanism for reporting of transmission errors to the users which initially requested the transmission. The cause of errors can vary from failures of the airlink to a temporary condition of insufficient holding buffers in a modem driving the transmitter. The network interfaces 45(a), (b) and (c) from Figure 3 propagate these errors to the IP module 35 by indicating a unique identifier for the datagram as well as a unique code which represents the nature of the error.

Figure 6 shows the behavior of a network interface and the IP router on reception of an error report. Input 1 from a network access device to an RF packet network interface 45 represents an error report which is assumed to encapsulate both the cause of the error and an identifier for the transmitted packet which failed to cross the airlink. (The network access device is shown to be a radio modem 50 (a), (b) or (c), as in the case of a hybrid Network Radio, but it could also be an adapter 85, as used in a Hybrid Network Gateway). The RF packet network interface propagates this report to the IP module 40, which, in turn, produces two (2) outputs.

Output 3 is an instruction to generate, and queue for transmission, an ICMP (Internet Control and Message Protocol) error message destined for the source of the datagram which failed to be transmitted. ICMP is the method used within the Internet for nodes to communicate "out-of-band"; i.e. to report problems and to implement diagnostic request-response protocols such as the well-known "ping". The specifications for ICMP may be found in Postel, J., "Internet Control Message Protocol", STD 5, RFC 792, USC/Information Sciences Institute, September 1981, the contents of which are incorporated herein by reference.

The ICMP message type used in Output 3 is commonly called DESTINATION UNREACHABLE, which means that the router was unsuccessful in forwarding the datagram. The specific cause of the failure is derived from the error report received from the interface 45, and is recorded in the CODE field of the ICMP message.

Output 4 is an instruction to modify, in accordance with the nature of the error, the impedance value of the RF path for the entry in the routing table which corresponds to the original destination of the datagram. When the source of the datagram, either mobile subscriber 10 or a fixed subscriber (see Figure 7), receives the ICMP DESTINATION UNREACHABLE message, it may choose to resend the datagram. Therefore, the choice of path for the re-transmitted datagram will take into account the new impedance value of the first RF path.

The formula for calculating the impedance of an RF packet network may vary with the technology and the commercial terms offered for the service. For instance, if

commercial rates vary with the number of octets in a packet and with the time of day, impedance measures should take these factors into account. When an error report is translated into DESTINATION UNREACHABLE, the impedance on this RF path is set to a value which cannot be exceeded on any other path, so that the RF path switch will avoid this path until conditions change.

Airlink Status Reporting

Some RF packet network technologies provide a mechanism for a mobile network access device, i.e. a radio modem, to generate reports regarding the status of the airlink, or the ability of the device to transmit on the airlink. With respect to the functionality of the present invention, the most important of these reports are the establishment and loss of RF contact with the packet network.

Figure 7 illustrates this mechanism in terms of how these reports are used by the Hybrid Network Radio to modify the routing table entries.

Input 1 is a status report from the modem 50(a) that RF contact with the network infrastructure has been lost. The RF packet network interface 45(a) propagates this report to the IP module (Output 2), which activates timer 36 in order to wait a suitable delay t before raising the impedance of RF path 60 to its maximum possible value (Outputs 4,5). Subsequently, the RF path switch will avoid sending datagrams along RF path 60 because its impedance will be as great as or greater than all other RF paths for packet networks to which the IP module is attached.

The impedance for the RF path 60 is reset to its original value when a status report is received from the radio modem 50(a) indicating that RF contact with the network infrastructure has been re-established. This is illustrated by Input 6 in Figure 7, which produces two (2) outputs. Output 7 is an instruction to reset the impedance measure for RF path 60 in the routing table. Output 8 is an instruction to generate and transmit across the airlink a *control packet* indicating that the mobile subscriber is within RF contact.

For any specific RF packet network, a control packet is defined as a packet which does not carry a payload for a higher-level protocol such as an IP datagram. In most RF packet networks, the packet header includes a field which is used to specify a *type*, wherein control packet types can be distinguished from other packets carrying payloads for higher-level protocols. If an RF packet network does not define such a field, then it must be defined, at the beginning of the user data area of each packet, in such a manner as to enable the transmitting and receiving network interfaces to recognize it. The packet header also includes an identification of the sender in the form of an address which is "native" to the RF packet network. This is commonly called a "hardware address" and is mapped within the receiver's routing tables to an IP address.

The control packet resulting from Output 8 in Figure 7 is called an RF_PATH_UPDATE packet. It informs the receiver that the sender has entered the coverage area of the RF packet network. The receiver can therefore change, if required, the impedance value for the RF path to the sender.

The timer 36 in Figure 7, activated when loss of RF contact is reported, is used to avoid unnecessary transmission in the case where there are spurious oscillations between loss and re-establishment of RF contact. In other words, if contact is lost, the timer may still be canceled if, before the interval has elapsed, a status report is received indicating re-establishment of contact. In such a case, the RF_PATH_UPDATE control would not be generated and transmitted. Interval t can be calibrated to each RF packet network technology.

What is claimed is:

1. A hybrid RF packet network comprising:

(i) a hybrid Network Radio enabling access to the hybrid network for a mobile subscriber and comprising:

(a) an internet routing module which interfaces to the hybrid network as a single abstract data link with a single Internet address.

(b) a RF path switch module comprising the means to choose the RF path of lowest impedance for each Internet datagram to be routed through the hybrid network.

(c) at least one data link interface to support access to the Internet through the hybrid network for a mobile subscriber computer.

(d) radio-modems and supporting airlink protocols for each of the RF packet networks combined in the hybrid network.

(e) means to change dynamically the impedance values associated with the RF path to a destination address on the hybrid network, based on transmission errors reports and transient condition reports generated by the radio modem.

(ii) a hybrid Network Gateway enabling access to the hybrid network for a fixed subscriber and comprising:

(a) an internet routing module which interfaces to the hybrid network as a single abstract data link with a single Internet address.

(b) a RF path switch module comprising the means to choose the RF path of lowest impedance for each Internet datagram to be routed

through the hybrid network.

(c) at least one interface to data link technologies to support access from the Internet through the hybrid network to any mobile subscriber as an IP-addressable node.

(d) adapters and supporting data link protocols for each of the data link technologies connecting to the proprietary gateways of the RF packet networks.

(e) means to dynamically change the impedance values associated with the RF path to a destination address on the hybrid network, based on transmission errors reports.

2. The system according to claim 1, wherein two (or more) separate and incompatible RF packet networks are combined into a hybrid network without requiring modification to either of the constituent networks nor the co-operation of either of the telecommunications carriers responsible for the constituent networks.

3. The system according to claim 2, wherein any subscriber to the hybrid network, whether fixed or mobile, is addressable by a single Internet address, and is reachable from anywhere in the Internet.

CLASSICAL INTERCONNECT SCENARIO

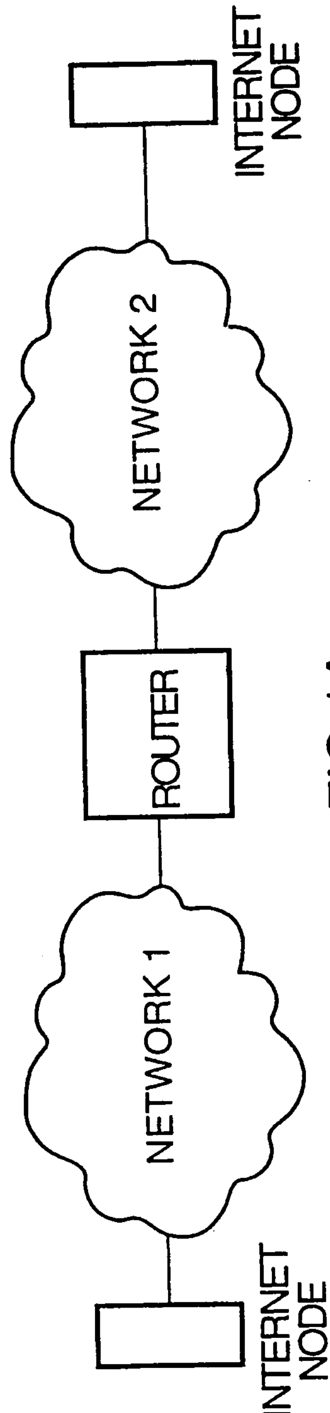


FIG.1A

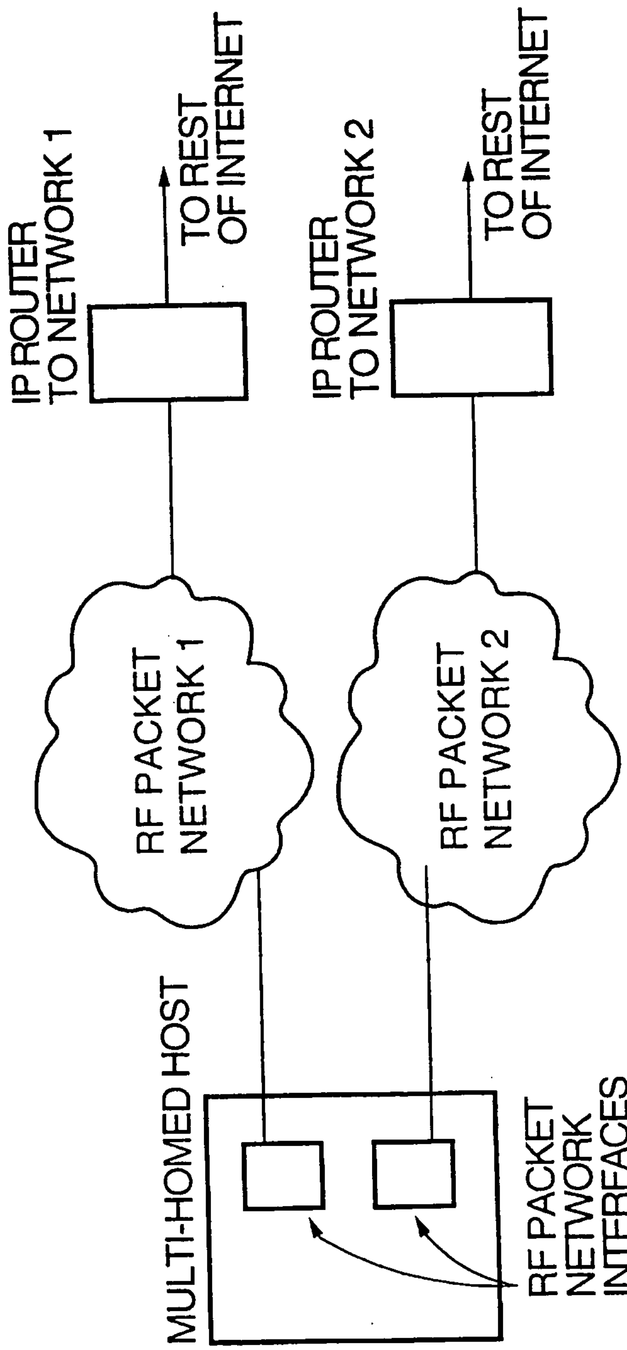


FIG.1B

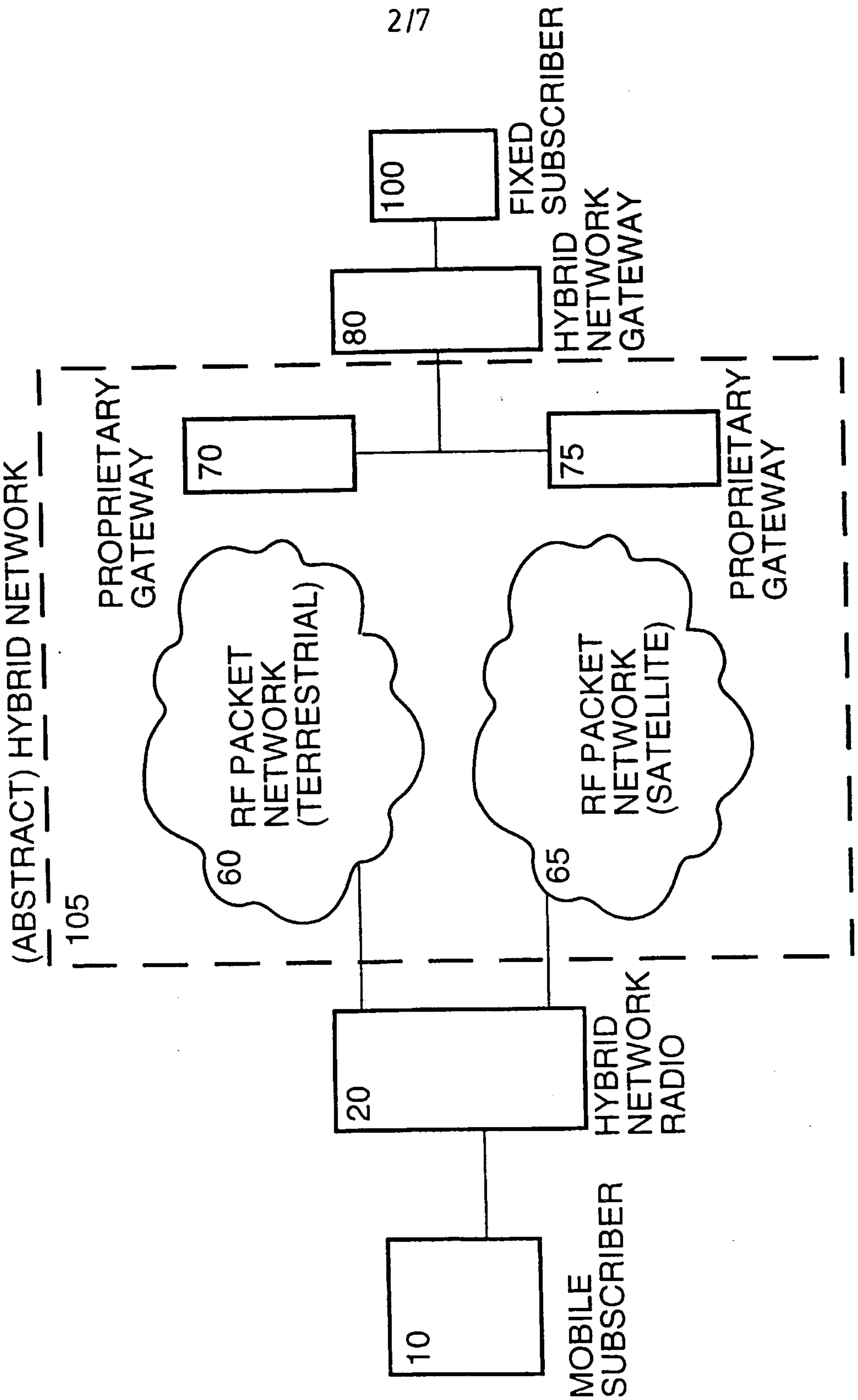

(ABSTRACT) HYBRID NETWORK
105
PROPRIETARY GATEWAY
70
75
PROPRIETARY GATEWAY
RF PACKET NETWORK (TERRESTRIAL)
60
RF PACKET NETWORK (SATELLITE)
65
80
HYBRID NETWORK GATEWAY
100
FIXED SUBSCRIBER
20
HYBRID NETWORK RADIO
10
MOBILE SUBSCRIBER

FIG.2

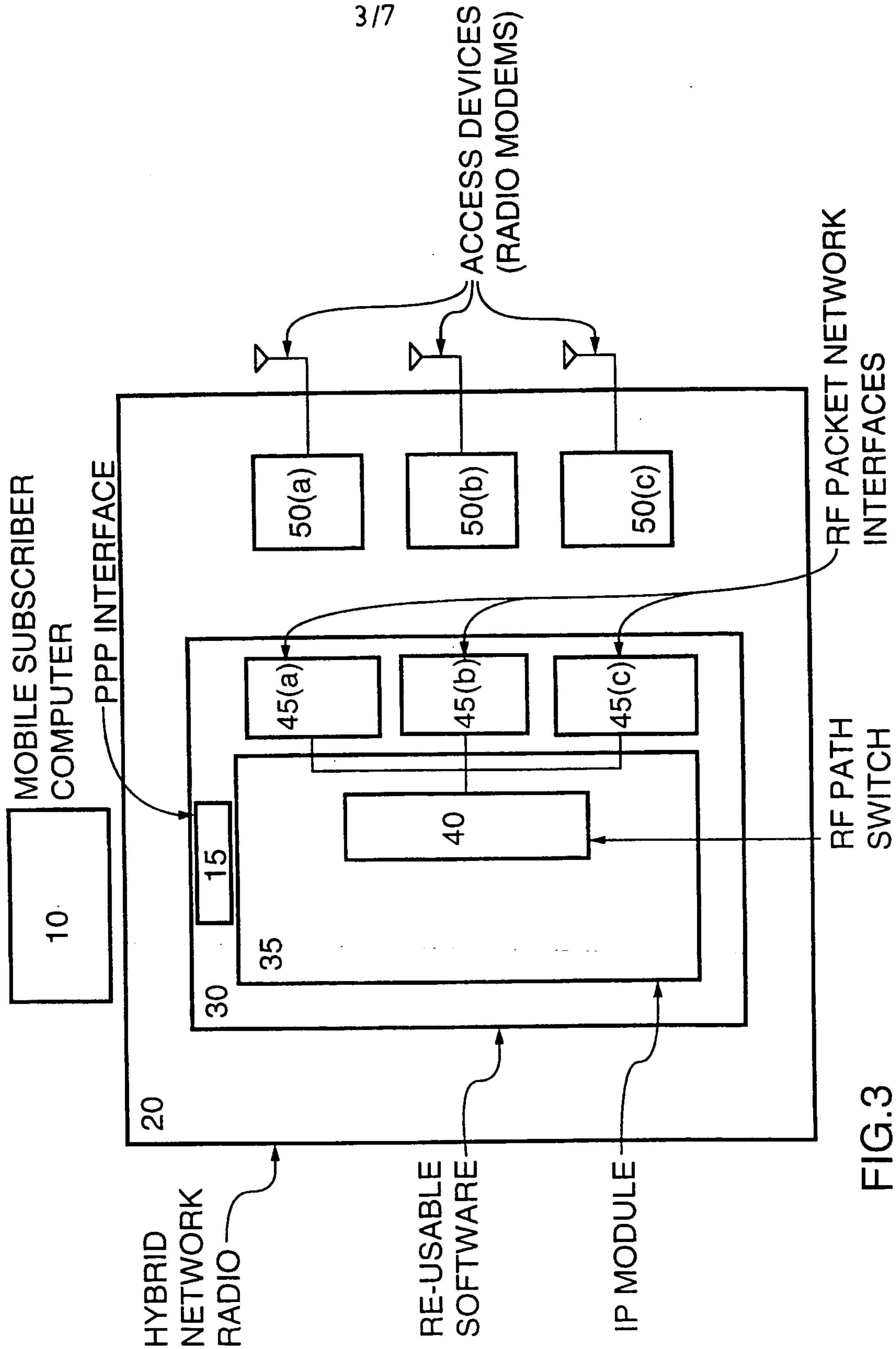
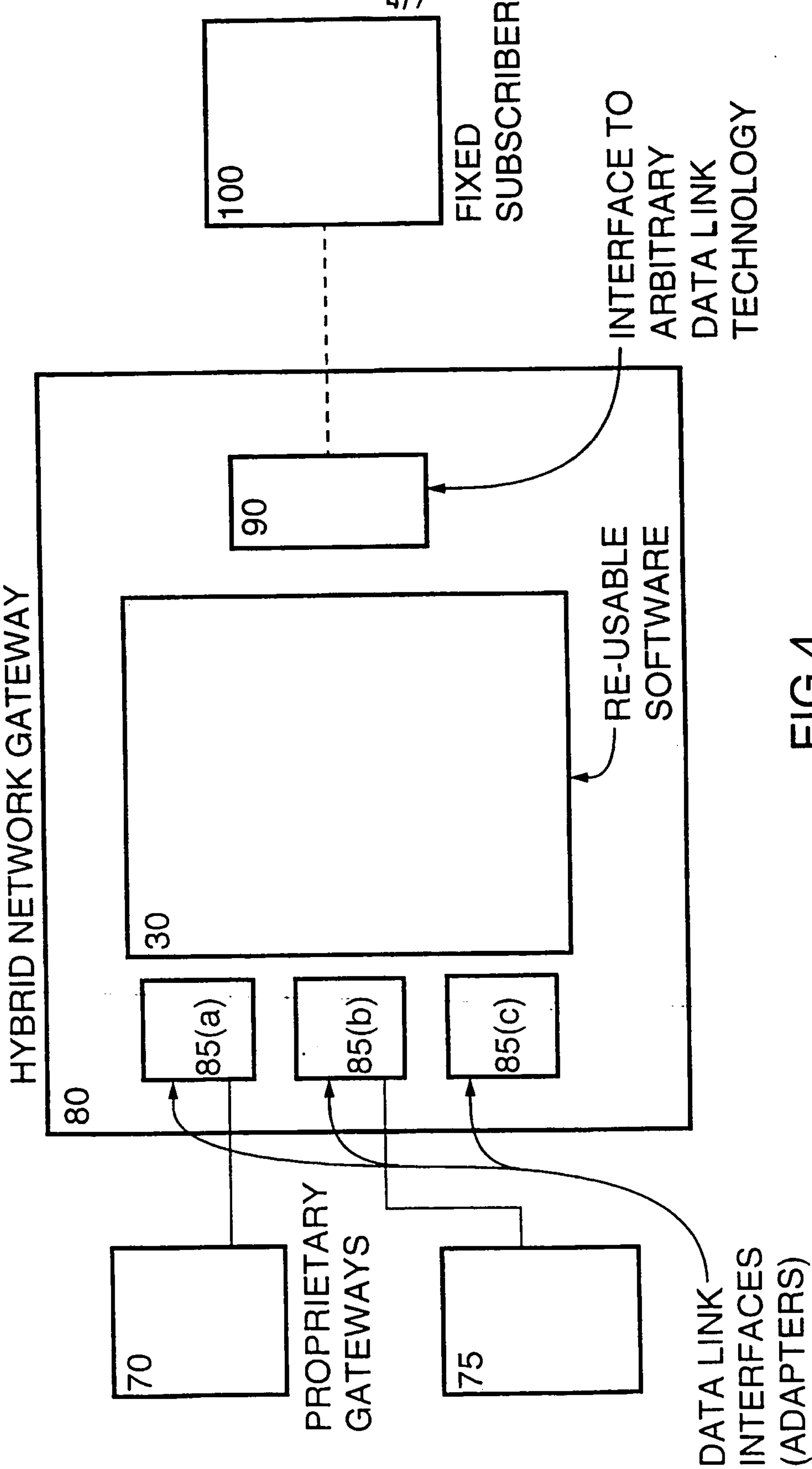

MOBILE SUBSCRIBER COMPUTER
10
PPP INTERFACE
15
ACCESS DEVICES (RADIO MODEMS)
50(a)
50(b)
50(c)
RF PACKET NETWORK INTERFACES
45(a)
45(b)
45(c)
40
RF PATH SWITCH
35
30
20
HYBRID NETWORK RADIO
RE-USABLE SOFTWARE
IP MODULE

FIG.3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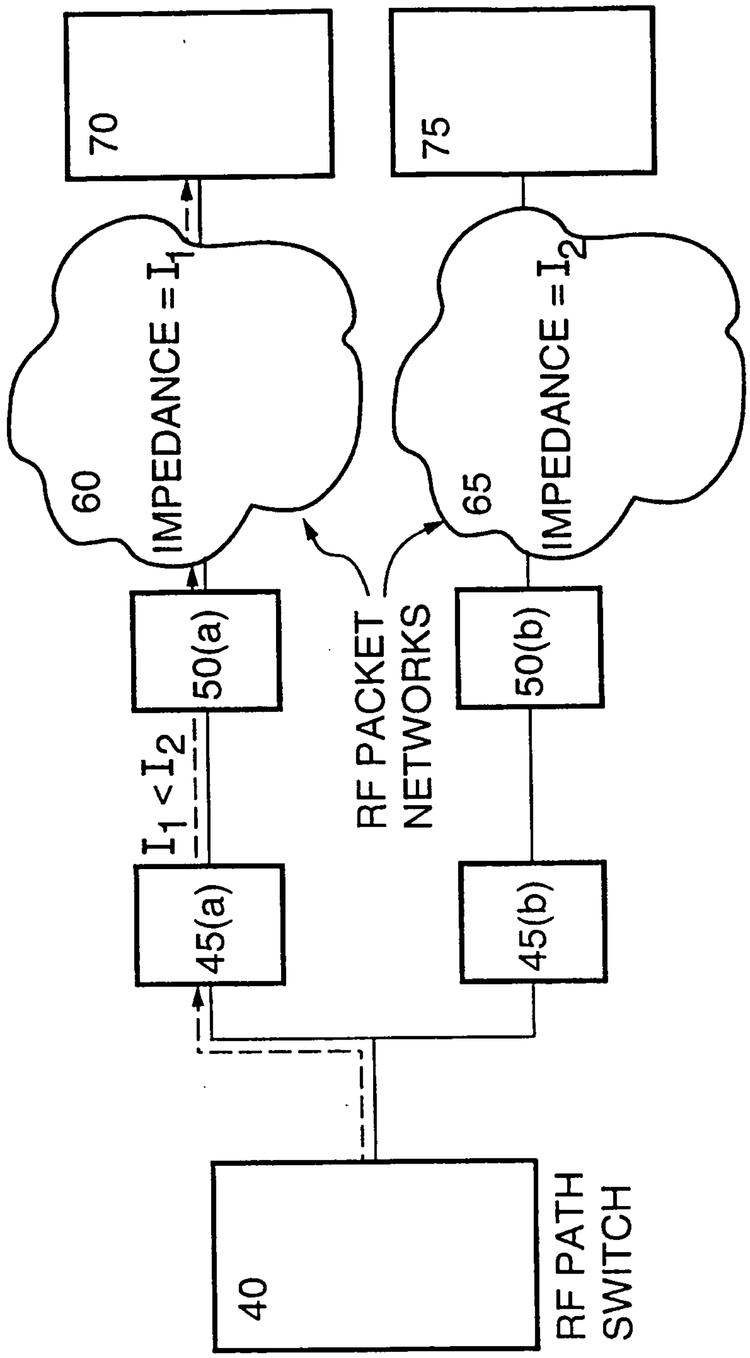
INTERFACE TO ARBITRARY DATA LINK TECHNOLOGY
HYBRID NETWORK GATEWAY
80
90
RE-USABLE SOFTWARE
30
85(a)
85(b)
85(c)
70
PROPRIETARY GATEWAYS
75
DATA LINK INTERFACES (ADAPTERS)

FIG.4



70
75
60
IMPEDANCE = I_1
65
IMPEDANCE = I_2
50(a)
50(b)
RF PACKET NETWORKS
$I_1 < I_2$
45(a)
45(b)
40
RF PATH SWITCH

FIG.5

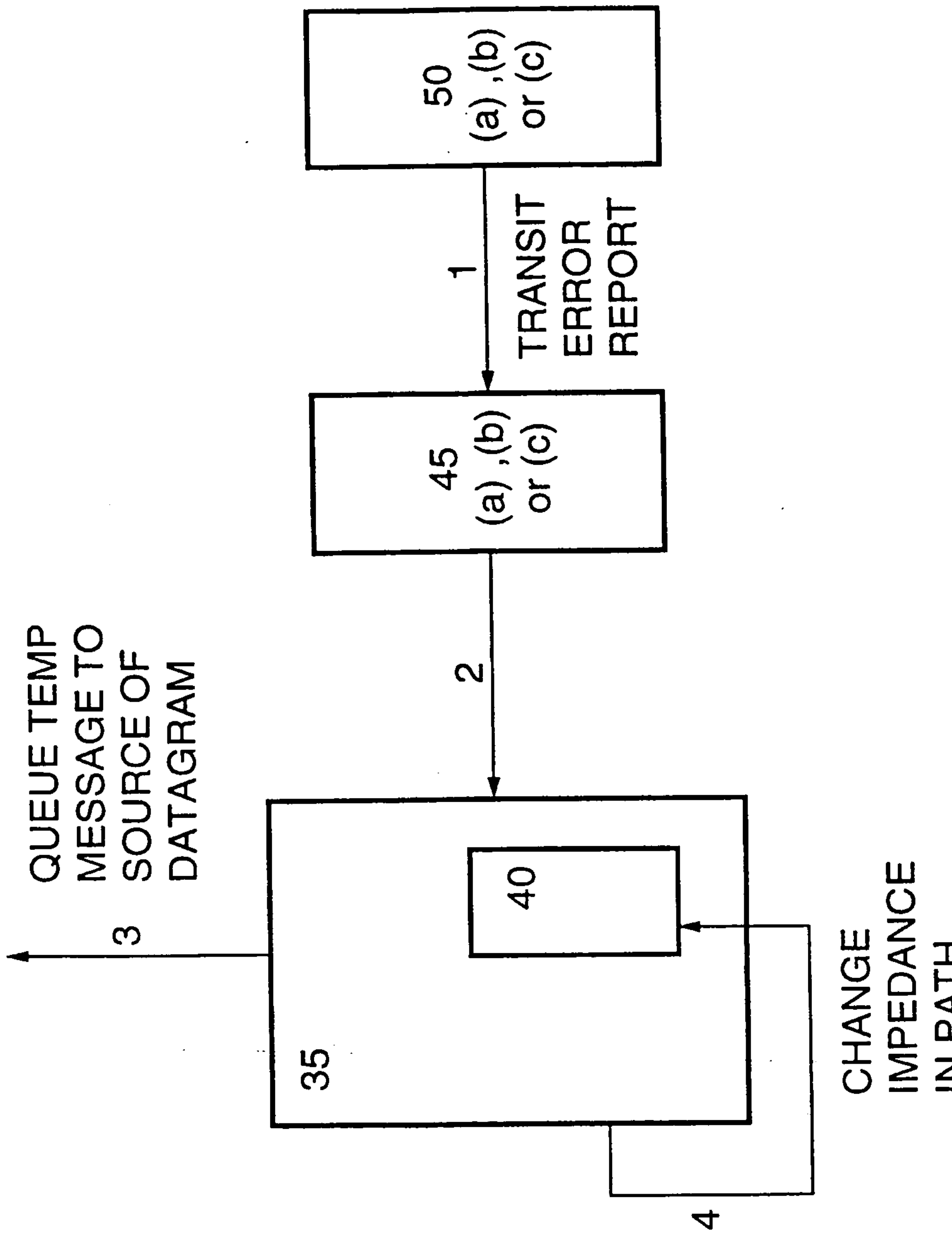

50
(a) ,(b)
or (c)
1
TRANSIT
ERROR
REPORT
45
(a) ,(b)
or (c)
2
35
40
3
QUEUE TEMP
MESSAGE TO
SOURCE OF
DATAGRAM
4
CHANGE
IMPEDANCE
IN PATH

FIG.6

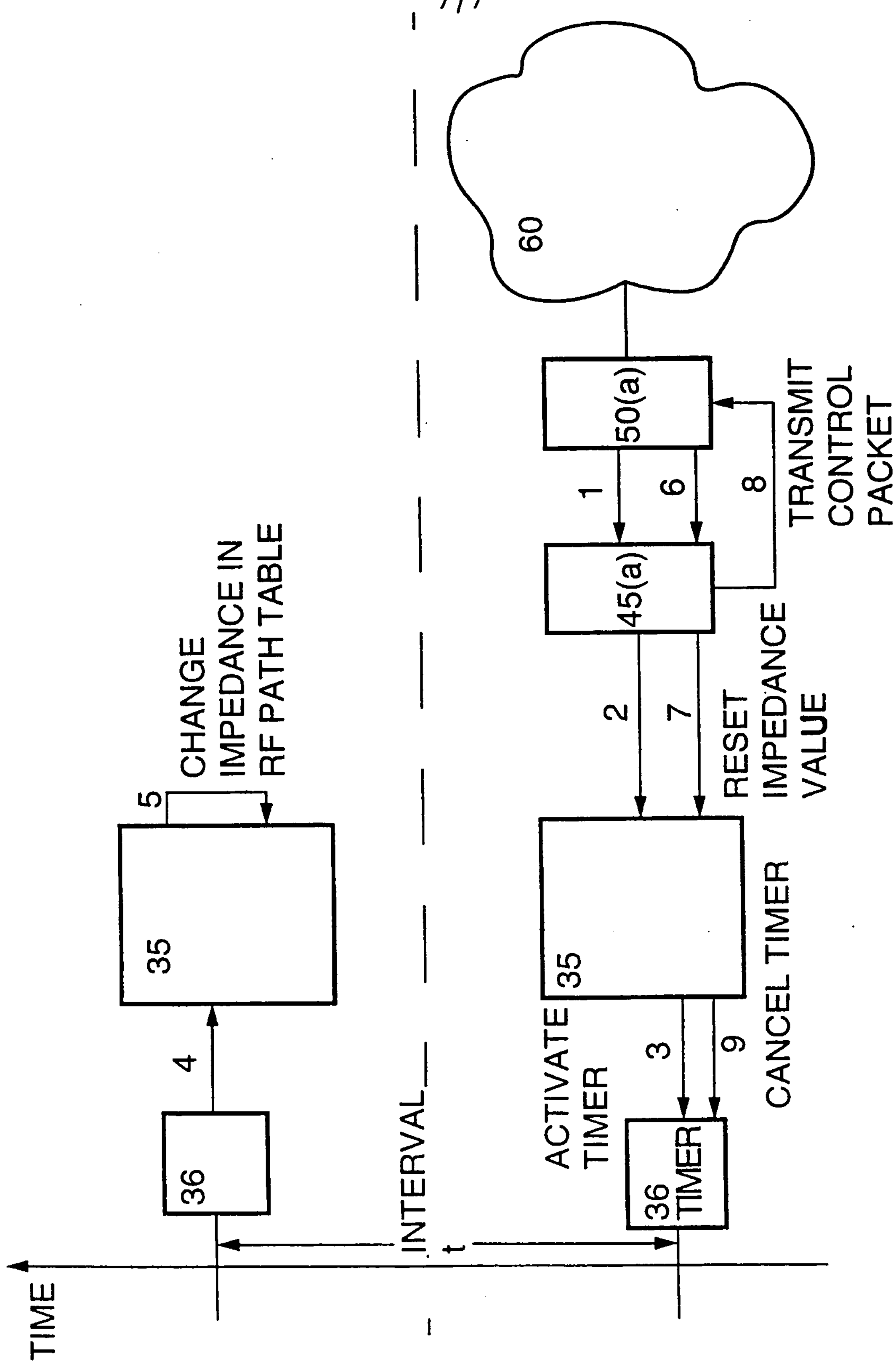

60
50(a)
45(a)
1
6
8
TRANSMIT CONTROL PACKET
2
7
RESET IMPEDANCE VALUE
35
CANCEL TIMER
3
9
ACTIVATE TIMER
36 TIMER
CHANGE IMPEDANCE IN RF PATH TABLE
5
35
4
36
INTERVAL
t
TIME

FIG.7

INTERNATIONAL SEARCH REPORT

International Application No
PCT/CA 98/00986

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H04L12/56 H04B7/185

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H04L H04B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4 999 833 A (LEE WILLIAM C) 12 March 1991 see abstract see column 1, line 12 - column 3, line 4 see column 4, line 20 - column 6, line 23 see column 7, line 25 - line 53 see column 11, line 44 - column 12, line 40 ---	1-3
Y	EP 0 801 354 A (IBM) 15 October 1997 see column 1, line 25 - column 2, line 38 see column 3, line 2 - column 7, line 55 see column 8, line 45 - column 9, line 30 see column 10, line 15 - column 11, line 43 --- -/--	1-3

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 February 1999	24/02/1999

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Vaskimo, K

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International Application No
PCT/CA 98/00986

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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A	US 5 073 900 A (MALLINCKRODT ALBERT J) 17 December 1991 see column 1, line 28 - column 2, line 33 see column 3, line 8 - column 4, line 52 see column 5, line 6 - column 6, line 39 ---	1-3
A	EP 0 615 391 A (ALCATEL NV ;BELL TELEPHONE MFG (BE)) 14 September 1994 see column 1, line 1 - column 2, line 32 see column 4, line 29 - line 36 see column 10, line 31 - line 43 see column 16, line 50 - column 18, line 19 see column 19, line 11 - line 38 see column 20, line 14 - column 21, line 48 ---	1-3
A	WO 95 25407 A (SIERRA WIRELESS INC ;TOMS NORMAN (CA)) 21 September 1995 see abstract see page 1, line 4 - page 6, line 3 -----	1-3

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/CA 98/00986

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